Federal Aviation Administration

Memorandum

Date: October 20, 2010

To: Manager, Transport Standards Staff, International Branch, ANM-116

From: Manager, Transport Airplane Directorate, ANM-100

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Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Airbus' Project on the Model A318 Series Airplanes, FAA Project # CP102A

ELOS Memo#: CP102A-T-P-2

Regulatory Ref: §§ 25.933(a)(1)(ii) and 25.1309(b)1

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate on the establishment of an equivalent level of safety finding for the Airbus Model A318-111, -112, -121 and -122 airplanes.

Background

Title 14 Code of Federal Regulations 25.933(a)(1)(ii) requires that "The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser." Airbus declared that Model A318 airplanes will not demonstrate compliance with § 25.933(a)(1)(ii). However, Airbus states that the A318 aircraft thrust reverser design protects against in-flight reverser deployment to an extent that provides a level of safety equivalent to that provided by direct compliance with the rule. Compliance with § 25.933(a)(1)(ii) is intended to completely eliminate all risk of catastrophic in-flight reverser deployment from normal operation. Under § 25.933(a)(1)(ii), any residual risk of catastrophic in-flight reverser deployment would be limited to scenarios involving unusual aircraft configurations, abnormal flight conditions or inappropriate flight crew actions. Therefore, any design intended to provide an equivalent level of safety to the subject rule must limit the residual risk of catastrophic in-flight reverser deployment to a similar level.

In general, the catastrophic risks from other aircraft system hazards are identified and managed through compliance with § 25.1309(b)(1). Therefore, compliance with this standard by the means delineated in the related FAA Advisor Circular (AC) 25.1309-1A should be part of any equivalent safety finding utilizing probability that a catastrophic in-flight deployment will not

occur. However, as documented in the docket justification for the subject § 25.933 rule, "A review of the past operating history of airplane engine thrust reversers indicates that fail-safe design features in the reverser systems do not always prevent unwanted deployment in flight. Many of these unwanted deployments are not caused by deficiencies in design but can be attributed to maintenance omissions, wear and other factors that cannot be completely accounted for in the original design and over which the manufacturer generally has no control even when comprehensive maintenance programs are established." This perspective has been re-enforced by an Aerospace Industries Association/FAA review of transport service history, which indicated that many of the reverser in-flight deployment incidents involved inadequate maintenance or improper operations. Other factors such as uncontained engine failure, unanticipated system failure modes and effects, and inadequate manufacturing quality have also played a role in in-service deployment incidents.

Therefore, in addition to the traditional reliability predictions provided in demonstrating compliance with § 25.1309, the equivalent safety finding to § 25.933 will require that the influences which could render that prediction invalid be identified and acceptable means for managing these influences be defined. To this end, compensating design assurance and continued airworthiness features must be provided.

Applicable regulation(s)

§§ 25.933(a)(1)(ii) and 25.1309(b)(1)

Regulation(s) requiring an ELOS

§ 25.933(a)(1)(ii)

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

The thrust reverser actuation system architecture of the Model A318-111 and -112 airplanes equipped with CFM Model CFM56 engines has three independent lines of defense to prohibit inadvertent in-flight deployment of the thrust reverser sleeves. The hydraulically actuated system controlled by the engine electrical control unit (ECU) has two locks, primary blocker door latches and secondary locks with each actuator release. An independent locking system is designed to isolate the thrust reverser from the aircraft hydraulic system. This system consists of a thrust reverser shut-off valve (SOV) upstream of the hydraulic control unit, a filter and associated plumbing, mounting and electrical supply. The SOV is electrically actuated from an independent signal from the spoiler elevator computer (SEC), bypassing the ECU command circuit.

The thrust reverser actuation system architecture of the Model A318-121 and -122 airplanes equipped with Pratt and Whitney Model PW6000 engines has three independent lines of defense to prohibit inadvertent in-flight deployment of the thrust reverser sleeves. The hydraulically actuated system consists of two doors, is controlled electrically, and has two primary locks and two tertiary locks on each door. The primary locks consist of a directional control valve and an isolation control valve that are controlled by the engine interface unit (EIU). The tertiary lock valve is controlled by an independent signal from the SEC, bypassing the EIU.

Airbus has demonstrated that in normal operation throughout the fleet life the Model A318 airplane is protected against catastrophic in-flight reverser deployment including:

1. A rigorous qualitative safety analysis to show that no single failure or malfunction, regardless of the probability, can result in a catastrophic in-flight reverser deployment. In addition to the traditional failure modes and effects analysis (FMEA), a top-down analysis, at least to the assembly level, was performed to assure that any obscure single failure modes were identified.
2. An average risk analysis in accordance with AC 25.1309-1A, which predicts that catastrophic in-flight reverser deployment will not occur in the fleet life of the Model A318 airplane.
3. A specific risk analysis which predicts that at the beginning of each flight the aircraft will continue to meet the "no single failure" criteria of analysis #1 above and that the risk of catastrophic in-flight deployment is less than 1x10-6 / flight-hour. This analysis was only required if the design can have contributory faults present for more than one flight. This analysis considered any aircraft configuration (including latent faults) anticipated to occur in the fleet life of the airplane type which is not proposed to be precluded from dispatch by the master minimum equipment list (MMEL). For the purpose of this analysis a configuration whose probability of occurrence is greater than 1x10-8 must be assumed to occur unless a lower total fleet exposure time was justified by prescribing either production or utilization limits.
4. Verification that the influences which could render these predictions invalid have been identified and acceptable means for managing these influences throughout the fleet life of the Model A318 airplane have been defined and implemented.

Explanation of how design features or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation

Although noncompliant with the regulation, a rigorous system safety analysis of the Airbus Model A318 airplanes has demonstrated that the risk of an inadvertent in-flight thrust reverser deployment is extremely improbable and is considered to provide an equivalent level of safety to demonstrating that the airplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper P-2, titled "Flight Critical Thrust Reverser." This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Transport Airplane Directorate has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number should be listed in the Type Certificate Data Sheet under the Certification Basis section (type certificates and amended type certificates) or in the Limitations and Conditions Section of the supplemental type certificate. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation(s):
14 CFR 25.933(a)(1)(ii), Reversing Systems
(documented in TAD ELOS Memo CP102A-T-P-2)

OCTOBER 21, 2016

Manager, TSS, Propulsion/Mechanical Systems
ANM-112

Date

ELOS Originated by TSS:	Project Engineer Douglas Bryant	Routing Symbol ANM-112